Local estimation of community stochasticity reveals increasingly predictable functional composition along a productivity gradient

LENGYEL, Attila*; Barabás, Sándor; Berki, Boglárka; Csecserits, Anikó; Gyalus, Adrienn; Kabai, Melinda; Lhotsky, Barbara; Rédei, Tamás; Ónodi, Gábor; Botta-Dukát, Zoltán
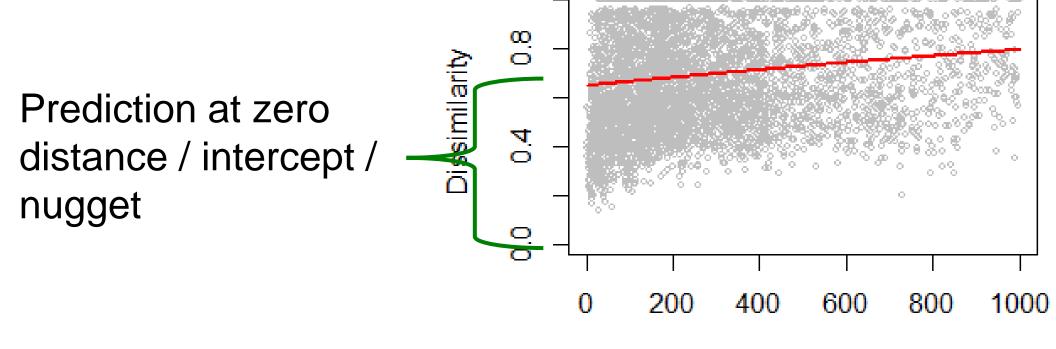
CENTRE FOR ECOLOGICAL RESEARCH, INSTITUTE OF ECOLOGY AND BOTANY, Vácrátót, Hungary
*presenting author, lengyel.attila@ecolres.hu

Virtual IAVS 2021

CENTRE FOR ECOLOGICAL RESEARCH

INTRODUCTION

Patterns of community composition and diversity can be attributed to **deterministic (predictable) and stochastic (unpredictable) processes**. Most studies tackle questions related to deterministic relationships, while the role of chance is rarely studied directly. **There has been no method for the measurement of the role of chance until the publication of Brownstein et al. (2012)**. Their method used the distance decay model to estimate the stochasticity (unpredictability) of a sample containing sample plots.

Here we extend the methodology of Brownstein et al. in a way that the unpredictability of individual plots can be estimated. Then, we examine how unpredictability changes along a productivity gradient on grasslands.
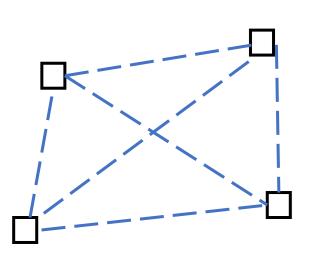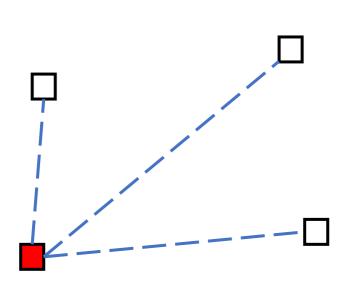
THE DISTANCE DECAY MODEL

Prediction at zero distance / intercept / nugget

The distance decay model in ecology is the compositional dissimilarity regressed on the spatial distances. **Brownstein et al.** (J. Ecology, 2012) suggested that at in an idealized case **at zero distance the dissimilarity should be zero**. They argue that the prediction made for zero distance, that is the **intercept** or **nugget** of the distance decay model, is a direct estimate of the **contribution of chance to community assembly**.

Brownstein et al.: **all pairs** are considered in a single model for a group of plots – **a single estimate of unpredictability for the entire the sample**

Our suggestion: only pairs containing a **focal plot** are considered – **estimates for individual focal plots**

AIMS

Our aims are:
1. Building on an existing method, introduce **a new procedure for the estimation of unpredictability** (the role of chance) for individual plots
2. To **estimate species-based and trait-based unpredictability** along a productivity gradient on sand grasslands

METHOD

Data:
- Three sites on the Kiskunság Sand Ridge (Hungary), inland sand dunes
- Grasslands along a productivity and topographical gradient: from open dry grasslands to marshes
- 369 vegetation plots of 4 m², percentage covers of vascular plants
- Trait data: canopy height, specific leaf area, seed mass
- NDVI field estimates for each plot

Analysis:
- Species-based and trait-based dissimilarity
- Distance decay models: dissimilarity vs. spatial distance; beta regression; only distances <1000 m
- Nugget estimates for each plot, change along NDVI

THE PRODUCTIVITY GRADIENT

Open dry grasslands
NDVI: ~0.2-0.4

Closed dry grasslands
NDVI: ~0.4-0.6

Semi-dry and mesic grasslands
NDVI: ~0.6-0.8

Wet meadows and marshes
NDVI: ~0.8-0.95

Productivity / NDVI gradient

RESULTS

Species-based nugget estimates showed no clear trend along productivity.

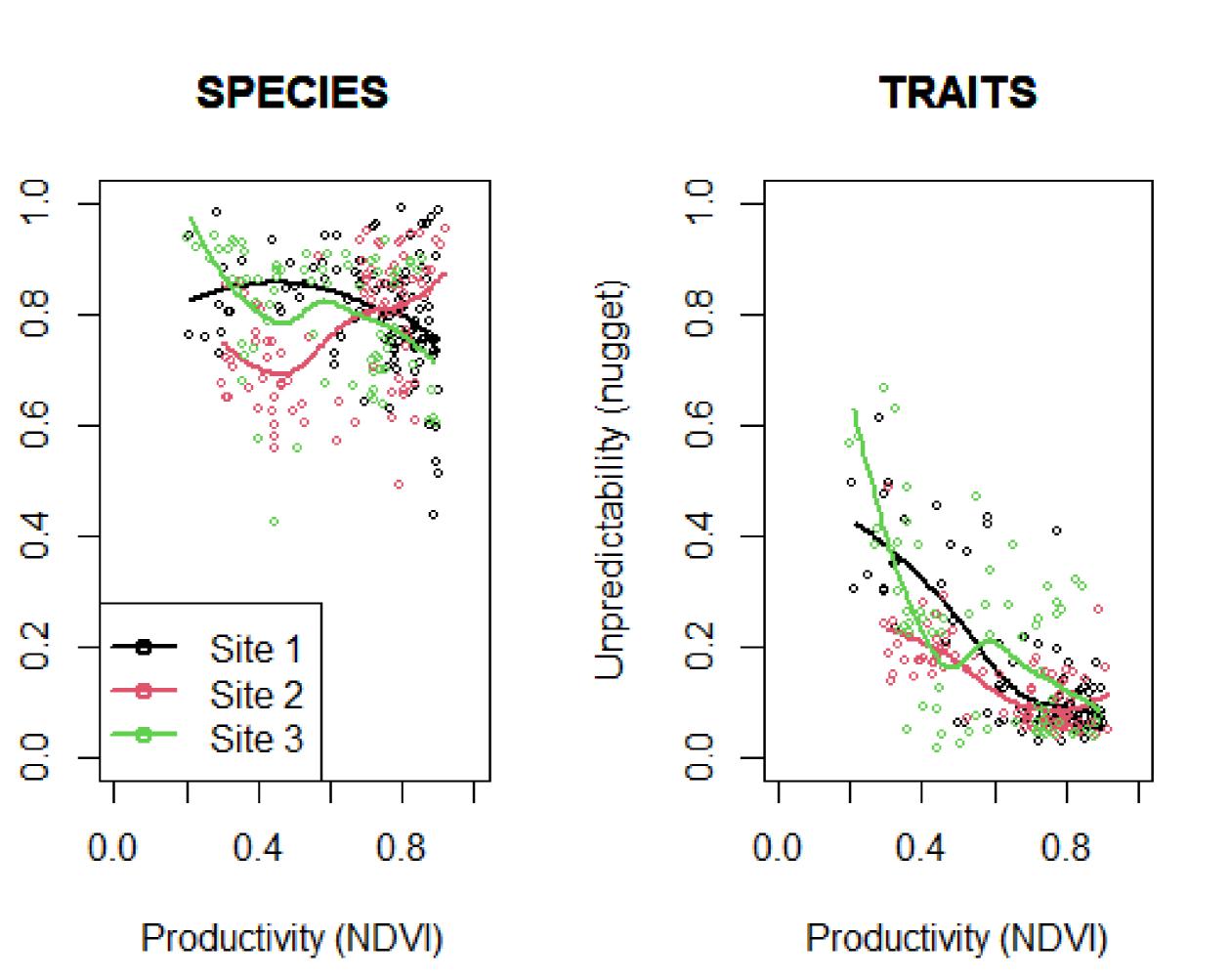Trait-based nugget estimates significantly decreased with increasing productivity.

Fig. 1. Estimates of plot-level predictability along the productivity gradient based on species (left) and traits (right).

CONCLUSIONS

We have several non-exclusive hypotheses for explaining the pattern detected.

1. **Poor local estimates of nugget**: Distance decay models of individual focal plots might be fitted poorly; however *this should not cause this type of artefact*.

2. **Unsuitable spatial configuration**: The sampling was not designed specifically for this study but *this should not cause this type of artefact*.

3. **Neutral effects**, e.g. species pool, structural constraints: *Surely these have effect on the result*. Species pool is likely higher at more productive habitats but its effect has not been tested formally yet.

4. **Assembly rules** change along the proructivity gradient
   1. **Different traits are selected** at low and high productivity: *This is a valid (partial) explanation*, see Lhotsky et al. 2016 J. Ecology
   2. **The strength of competitive exclusion changes**, so at more productive sites more similar species are able to co-exist. *It should be tested*.

Nevertheless, the plot-level estimates of unpredictability reveal intriguing hypotheses on community assembly.

REFERENCES

Brownstein et al. (2012), Chance in plant communities: a new approach to its measurement using the nugget from spatial autocorrelation. J Ecology, 100: 987-996.

Lhotsky et al. (2016), Changes in assembly rules along a stress gradient from open dry grasslands to wetlands. J Ecology, 104: 507-517.

ACKNOWLEDGEMENTS

Presented at: Virtual IAVS

Theory and methods in vegetation science · Attila Lengyel

149-PLT · IAVS2021